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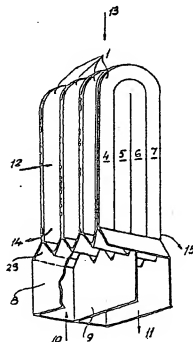
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(54) Title: PLATE HEAT EXCHANGER

(57) Abstract

A plate heat exchanger, which comprises a plurality of plates (1) arranged to the side of each other, each plate consisting of two metal sheets (2, 3), which are welded one to the other along two parallel edges and have longitudinal bulgings in parallel with said edges. The invention has the object to produce a plate heat exchanger where the medium flowing within the plate is guided in a direction in parallel with the extension of the bulgings and back in the same direction. Each plate (1) is formed with a turning zone in that the bulgings in pairs meet in such a manner, that in the sheet plane two outermost bulgings meet along a semicircle line, thereafter the two bulgings next to the outermost ones, and so on, and the number of bulgings is an integer number.



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Plate heat exchanger

This invention relates to a plate heat exchanger, which comprises a plurality of plates arranged to the side of each other and each consisting of two metal sheets, which are welded one to the other along two parallel edges and have longitudinal bulgings in parallel with said edges. The present invention has the object to produce a plate heat exchanger where the medium flowing within the plate is guided in a direction in parallel with the extension of the bulgings and back in the same direction. This arrangement implies the further gain that substantially all surfaces of the plates flown through by a medium participate in the heat exchange. This is not the case, for example, when at one end of the plate a box is used for turning the medium flowing through the plates.

In order to achieve the aforesaid object, the invention has been given the characterizing features defined in the attached claims. An embodiment of the invention is described in the following, with reference to the accompanying drawings, in which

Fig. 1 is a perspective view seen obliquely from below of, four plates with associated intakes, the casing about the heat exchanger being omitted,

Fig. 2 is a lateral view on an enlarged scale of the plates seen against the edge joints of the plates,

Fig. 3 is a section along the line III-III in Fig. 2 and, thus, a horizontal view of a metal sheet comprised in a plate.

Fig. 1, thus, shows in a perspective way four plates, which are arranged to the side of each other and provided with an intake. The plates 1 at the embodiment shown are four in number and assembled of two metal sheets 2 and 3 so as to form a hollow flow body, see Fig. 2. Each plate has four passages 4, 5, 6 and 7. At the upper end of the plates a turning zone is formed so that the passage 4 turns into the passage 7, and the passage 5 turns into the passage 6. The design of the passages will become apparent in greater detail from the following. At the lower edge of the plates a distribution connecting piece 8 is

attached, within which a partition sheet 9 is located to separate the passages 4 and 5 from the passages 6 and 7. A medium is hereby caused to flow into the plates according to arrow 10 and out of the plates according to arrow 11. In Fig. 1 the distribution connecting piece 8 is shown on an enlarged scale relative to the plates in order to simplify the illustration. The length of the plates 1, of course, can be varied entirely as desired in respect of the size of the heat surfaces. The second medium participating in the heat exchange flows between the plates 1, for example according to arrow 12. The flow path may also be from above according to arrow 13 and thereafter outward at the arrows 14 and 15. A casing of sheet metal is then placed about the plate package with an inlet provided at the upper edge and one or several outlets provided close to the areas marked by the arrows 14 and 15.

Figs 2 and 3 illustrate the structure of the plates and of the metal sheets constituting the same. Fig. 3 is a section along the line III-III in Fig. 2 and, thus, may be said to illustrate a metal sheet 3 seen from the inside. The metal sheet has longitudinal bulgings 16, 17, 18 and 19, which may consist of valleys of symmetric shape, for example a portion of an arc. In Figs 2 and 3 a special shape is shown where the valleys have a cross-sectional shape resembling half a pear, see the dashed lines 20. This shape, thus, is asymmetric relative to a central line in the valley. In order to render it possible, for example, for the passages 16 and 19 to meet in the turning zone, i.e. at the upper end of the plates, the asymmetric shape for the passages 16 and 19 must be identical but reversed, as also appears from Fig. 3.

The cross-sectional shape of the valley 17 is equal but reversed to that of the valley 16, and the cross-sectional shape for the valley 18 is reversed relative to the cross-sectional shape for the valley 17. A cross-section along the line II-II in Fig. 3 thereby yields the dashed lines in the upper part of Fig. 2 which are designated by 20 in order to make it understood that they are in agreement with the dashed lines 20 in Fig. 3. In Fig. 3, thus, an underlying metal sheet with the valleys 16-19 is shown. In order to obtain a plate, an overlying metal

sheet formed with corresponding valleys is placed thereon. When the metal sheets are positioned one against the other, the valleys are closed and form passages. In each plate, thus, four passages 4-7 according to Fig. 1 are formed. The cross-sectional shape of the passages in the turning zone is apparent from the dashed lines in the upper part of Fig. 2.

In Fig. 2, the numeral 21 designates a sheet metal casing about the plate package, and in said casing the medium is included which flows about and between the plates.

The distribution connecting piece 8 is shown in Fig. 3 by a cross-section through the lateral walls and also a cross-section through the partition wall 9. For connecting the side walls in the distribution connecting piece 8 to the plates, the lower edges of the plates have been flattened, so that a cross-section through the plate has V-shape. Said V-shape 22, which appears from Figs 1 and 2, implies that the plates have a V-shaped opening with straight edges. The sides 8 are cut open to corresponding V-shape, so that "teeth" 23 are formed which are welded on corresponding edges of the plates. The walls 8 preferably are designed with substantial thickness, and in the "teeth" 23 recesses 24 with corresponding V-shape are made, so that an upright edge 25 extending in V-shape is formed. Said edge 25 abuts the free edge of the plates, and owing to the edge 25 projecting from the side 8 the possibility of welding to the lateral edge of the plate is improved. The plates in general are jointed all about along the edges 26.

The structure has a good strength, and high temperature differences can be permitted. The plates bend only slightly, and attachments in turning boxes or the like are not affected.

The flow function of the medium flowing in the plates is shown in Fig. 1. The medium flows in at arrow 10, is distributed in the passages 4 and 5, flows upward to the upper end of the plates, turns in the so-called turning zone, flows back in the passages 6 and 7 and out through the distribution connecting piece 8 according to arrow 11. See also Fig. 3. The medium flowing outside the plates can be guided in that a gasket strip, for example of teflon, is laid in between the outer surfaces of two

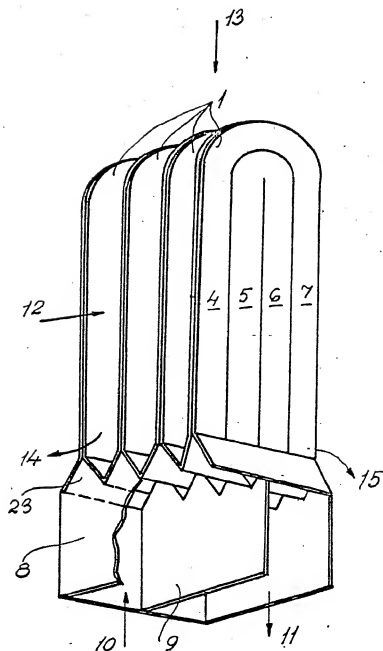
plates along the valley line between the passages 5 and 6, i.e. between the valleys 17 and 18. Hereby a pure countercur-rent between the media can be obtained.

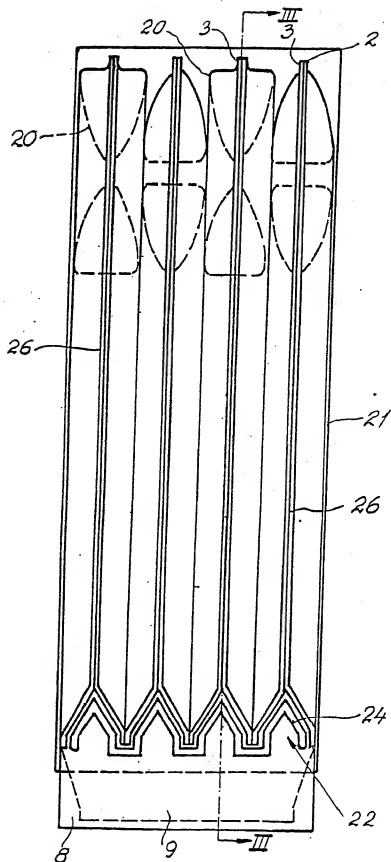
C L A I M S

1. A plate heat exchanger comprising a plurality of plates, which are arranged to the side of each other, and each of which consists of two metal sheets, which are welded one to the other along two parallel edges and have longitudinal bulgings in parallel with said edges, c h a r a c t e r i z e d i n that each plate at one end is formed with a turning zone in that the bulgings in pairs meet in such a manner, that in the sheet plane two outermost bulgings next to the outermost ones, a.s.o., and the number of bulgings is an integer number.

2. A plate heat exchanger as defined in claim 1, c h a r a c t e r i z e d i n that bulgings connected in pairs are symmetrical in cross-sectional shape.

3. A plate heat exchanger as defined in claim 1, c h a r a c t e r i z e d i n that bulgings connected in pairs are asymmetrical in the cross-sectional shape and reversed one relative to the other.



*Fig. 2*

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE79/00114

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

F 28 F 3/00

II. FIELDS SEARCHED

Minimum Documentation Searched *

Classification System

Classification Symbols

IPC

B 21 D 53/02, 53/04; B 23 P 15/26; F 24 H 3/00; F 28 D 1/00
7/06, 9/00; F 28 F 3/00, 3/02, 3/04, 3/08, 3/12, 3/14

Documentation Searched other than Minimum Documentation
to the extent that such Documents are included in the Fields Searched *

000/000

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category *	Citation of Document, ¹⁵ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US, A, 3 466 726 published 1969, September 16, Unto U Savolainen	1, 2
A	DE, B, 321 510 published 1975, April 10, Vogel & Noot Aktiengesellschaft	1
A	SE, B, 367 701 published 1974, June 4, Parca Norrahammar AB	
L	FR, A, 1 245 012 published 1960, September 26, La Soudure Autogène Française	

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"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principles or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search ¹

1979-07-25

Date of Mailing of this International Search Report ¹

1979-08-02

International Searching Authority ¹

Swedish Patent Office

Signature of Authorized Officer ¹⁹

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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Continuation Fields Searched

Deutsche Klassen: 7c:24 (only heat exchangers);
 17D:1/01-1/04; 17e:2/22; 17f:5/30-5/32, 12/05;
 36c:9/01, 9/06, 9/32, 9/33

US Classification: 29:157.3; 113:118; 165:152,
 164, 165, 166, 185

V ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹⁰

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____ because they relate to subject matter ¹¹ not required to be searched by this Authority, namely:
2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹², specifically:

VI ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ¹³

This international searching authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

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